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Usability Evaluation of Hospital Information System: A Cross-Sectional Study

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Abstract
Introduction: Hospital information system (HIS) is software that collects, gathers, retrieves, and publish data and information and Usability evaluation result in objectives achievement. This study aimed to evaluate HIS usability in educational hospitals of Shiraz University of Medical Sciences (SUMS) in Shiraz, Iran. *Material*: The study conducted from February to April 2017 and the population comprised 689 users of 7 HISs in 7 hospitals of SUMS. The data collected using a questionnaire according to Isometric 9241-110 with a 5-point Likert scale. *Results*: The highest and lowest subscales of usability belong to the *Conformity* with user expectations and Self-descriptiveness, respectively. Except for the Suitability for individualization ($p=0.156$) and *Suitability for learning* ($p=0.197$), other subscales were significantly different between hospitals ($p<0.05$). *Conclusions*: The total system's usability was evaluated above medium and users more focused on task-related items and less noted technical features.

Keywords: Usability; Hospital Information Systems (HIS); Evaluation; Human System Interaction

Introduction

Information Technology (IT) is a pragmatic solution for healthcare organizations in maintaining a balance between improving services and growing demands [1]. Health IT and Hospital Information System (HIS) enhance the quality and decrease the cost of healthcare services and offers advanced opportunities to improve the performance of health organizations and public health [2, 3]. HIS is a complex of software that collect, gather, retrieve, and publish data and information in a hospital. HIS has several modules that most important are radiology, laboratory, and nursing information system [4].

HIS implementation leads to a decrease rate of medical errors, enhance personnel performance, allocate resources properly, distribute information faster, and, finally, achieve higher users' satisfaction [5-7]. HIS enhances the accessibility of information about patients and hospitals and improves policymaking in the health industry [8]. The significant role of HIS in healthcare organizations is well-defined [9], but also failures such as inability to meet objectives, difficulties in

IT acceptance, and lack of system quality are remarkably widespread [10-12]. Therefore, problematic aspects must be identified and addressed as soon as possible [13].

HIS implementation is a complex process and requires insightful, clear, and comprehensive evaluation to deliver proper and continuous feedback to ensure success and avoid disappointment [1]. Researchers and system professionals emphasize HIS evaluation using a valid and effective approach [14]. A valid evaluation must be conducted to get the most benefits out of HIS [12]. On the other hand, effective evaluation helps with the better development and improvement of the HIS [15].

Several approaches are used for HIS evaluation all around the world [15] that one of the most important and most commonly used is usability testing. Usability is referred to the user' s experience in performing business processes with the system in terms of usefulness, ease of use, and satisfaction [16] and is the main criterion for information system quality [17]. Usability problems can lead to several challenges for health care organizations [18]. Inappropriate user interface and System mismatch with clinical workflow are the main reasons users do not use the system [7].

Usability can be evaluated when the user interacts with the system in a specific context [19] and investigated different dimensions, but usability evaluation generally emphasizes the desirability degree of user-computer interaction according to user perception [8].

There are multiple methods for evaluating HIS that grouped into two main: user-based and expert-based [20]. Surveying user views is an efficient way to determine usability problems. In the time of this study, the literature showed that usability evaluation had not been performed in Shiraz hospitals. Given the importance of the HIS and the role of users in its success, this study aims to evaluate HIS in seven educational hospitals affiliated to Shiraz University of Medical Sciences(SUMS), in Shiraz, Iran.

Material and Method

Methods

A cross-sectional study was conducted from February to April 2017. SUMS has implemented HIS in one educational hospital since 2004, and by a five-year plan, the system was deployed to all seven educational hospitals affiliated to SUMS Hospitals A and B are multi-specialty, and others are specialty or subspecialty hospitals. The HIS of all hospitals had four basic modules, including Nursing Information System, Laboratory Information System, Radiology Information System, and Medical Records Information System, and the participants included users from these departments. Users log with their credentials and can view, enter, edit, or delete data according to their roles and responsibilities.

Technical information: To assess the participants' viewpoint about the HIS, we applied a questionnaire designed according to the Isometric 9241-110(previously 9241-10) standard and its' 7 subscales defining usability (Table1). Each question of the questionnaire is designed based on a 5-point Likert scale (very high = 5, high = 4, medium = 3, low = 2 and very low =1).

Statistics

Descriptive statistics such as frequency distribution (n) and percentage (%) were used to present discrete variables and mean± (SD), minimum and maximum are used to present continuous variables. One sample t-test was applied to compare the mean score of each scale against an average value of "3". Chi-square test was used to assess the relationship between discrete variables, and independent sample T-test and one-way ANOVA were used to compare the mean scores of each scale in different sex and education, respectively. Furthermore, Pearson's correlation test was done to identify the correlations of age, job background, and working experience as a HIS user with the mean total score of the questionnaire. Moreover, the scores of each of the subscales categorized undesirable (less than 50%), relatively desirable (51% – 80%), and desirable (more than 80%). The IBM SPSS version 22.0 was used for data analysis and P values <0.05 considered significant.

Table 1. Usability subscales according to Isometric 9241-110

Subscale	Description	No. of items
Suitability for the task	The range of which tasks are performed without any duplicate and redundant process and only task-related sections are shown to the user	15
Self-descriptiveness	The range of which system facilitates the user's understanding via providing proper and perceptible feedbacks when an error occurs.	12
Controllability	The range of which user is free to move between different views and screens and navigate the system properly	11
Conformity with user expectations	The range of which user can interact effectively with the system based on her(his) experience, knowledge, and education	8
Error tolerance	The range of which user tries to fix system errors or hangs up when users perform their tasks	15
Suitability for individualization	The range of which the user is allowed to make changes in the system according to personal, departmental, and organizational preferences.	6
Suitability for learning	The range of which system is completely learnable for user by a reasonable effort	8

Results

The reliability of the questionnaire was assessed using the internal consistency coefficient (Cronbach's alpha) which was 0.95 for the total of 75 items of the questionnaire and ranged from 0.72 to 0.86 for the 7 subscales. The participants were 689 users who had worked in hospitals A (138), B (144), C (96), D (76), E (66), F (84), and G (58). The questionnaires were distributed among all participants and after assessing the completed questionnaires, 27 questionnaires were excluded because more than 80% of them were not completed; there for the final sample size decreased to 662 individuals (Figure 1).

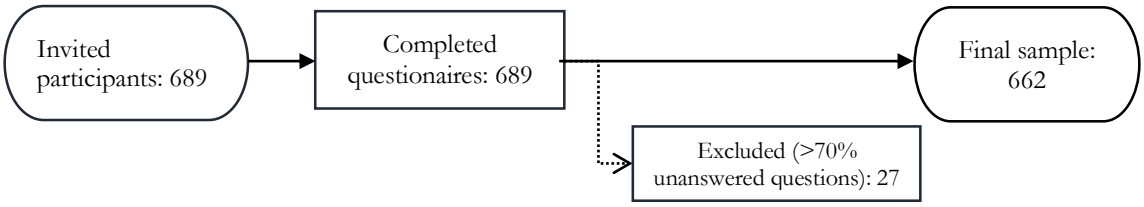

Figure 1. The total participants and final sample size

The majority of the participants were female with a mean age of 32.28±6.05 years. Most of those (79.9%) had an academic education (Table2).

The highest and the lowest mean score of 7 subscales were related to Conformity with user expectations and Suitability for individualization, respectively (Table 2). The Pearson correlation coefficient showed no significant correlation between age ($p=0.71$) and occupational background ($p=0.32$) with the mean scores of the 7 subscales of HIS. Furthermore, the mean scores of the seven subscales were compared in different sex ($p=0.41$) and education groups ($p=0.86$) but the results showed no significant difference. The results of ANOVA showed that except for the Suitability for individualization and Suitability for learning, other subscales were significantly different between hospitals (Table3).

The users evaluated the seven subscales of usability, as relatively desirable in the given hospitals. Conformity with user expectations and Error tolerance had the highest and the lowest desirability,

respectively (Figure 2).

Table 2. Descriptive statistics of the characteristics of HIS

Characteristics	Category	n (%)
Gender	Male	220 (33.2)
	Female	442 (66.8)
Education	No academic degree	133 (20.1)
	Associates degree	89 (13.4)
	BSc	273 (41.2)
	MSc and Upper	138 (20.9)
	No response	29 (4.4)
Age (year)	<30	316 (47.7)
	30-40	286 (43.2)
	41-50	56 (8.5)
	>50	4 (0.6)
Job topic/department	Nursing	431 (65.1)
	Laboratory	78 (11.8)
	Medical records	68 (10.3)
	Radiology	58 (8.8)
	Pharmacy	27 (4)
Background (year)	<10	450 (68.0)
	10-20	182 (27.5)
	>20	30 (4.5)
Work in HIS position (year)	<5	420 (63.5)
	5-10	224 (33.8)
	>10	18 (2.7)

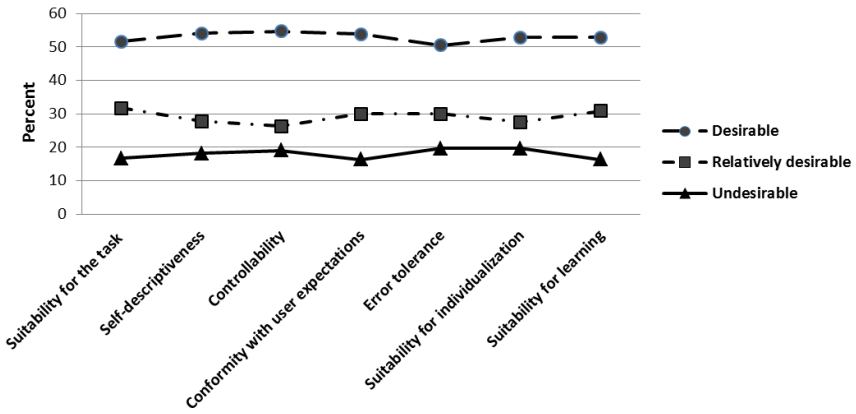

Figure 2. Comparison of the level of the desirability for seven subscales

Table 3. The mean score of usability subscales in hospitals affiliated to SUMS

Hospital	Suitability for the task	Self-descriptiveness	Controllability	Conformity with user expectations	Error tolerance	Suitability for individualization	Suitability for learning	Mean
A	3.41±0.51	3.43±0.69	3.58±0.69	3.62±0.66	3.39±0.73	2.95±1.07	3.17±0.98	3.36±0.23
B	3.30±0.49	3.05±0.65	3.18±0.65	3.37±0.67	3.25±0.62	2.74±0.93	3.12±0.75	3.14±0.21
C	3.06±0.49	3.03±0.74	3.17±0.82	3.19±0.82	3.09±0.74	2.65±0.96	3.74±0.87	3.13±0.32
D	3.12±0.58	3.14±0.68	3.18±0.62	3.44±0.95	3.12±0.71	2.84±0.86	3.15±0.87	3.14±0.17
E	3.25±0.42	3.09±0.57	3.29±0.53	3.23±0.56	3.06±0.39	2.56±0.66	3.09±0.75	3.08±0.25
F	3.23±0.54	3.06±0.59	3.21±0.64	3.48±0.68	3.07±0.66	2.67±0.85	3.03±0.93	3.11±0.25
G	3.20±0.48	3.29±0.57	3.34±0.60	3.57±1.01	2.99±0.53	2.44±0.71	3.09±0.72	3.13±o.36
Overal	3.25±0.59	3.17 ± 0.67	3.28 ± 0.68	3.42 ± 0.76	3.18± .66	2.73 ± 0.91	3.20± 0.85	-
P-value	0.015	0.007	0.006	0.043	0.036	0.156	0.197	-

Discussion

The results of this study show that the highest subscales of HIS of SUMS in Shiraz usability include the *Conformity with user expectations*, *Controllability*, and *Suitability for the task* (Table 3).

Almost eighty-five percentage of users evaluated the *Conformity with user expectations* desirable or relatively desirable (Figure 2). *Conformity with user expectations* is a major factor in system success [21]. The system must be user-friendly so as not to put tension on the user while performing tasks [22]. Thus, eliminating tasks unrelated to users' real work could improve the *Suitability for the task of information systems* [19]. The possibility of stopping running procedures as needed should be considered in future developments of these systems.

The controllability of studied HISs was desirable or relatively desirable according to 81.6% of users. Controllability has reached when the system allows users to go forward and backward in the system and stop the procedure based on the user's decision [23]. Providing proper help icons supports users to make better decisions and choose the right option. Finally, 81.1% of users believed that the suitability for the task was desirable or relatively desirable. Imposing unnecessary tasks on the user results in confusion, a waste of time, and discontent. On the other hand, full compliance of the system with the hospital's workflow and use of terms similar to the real work environment leads to increased user satisfaction and system impact.

Also, the lowest mean scores belong to *Suitability for individualization*, *Self-descriptiveness*, and *Error tolerance* (Table 3). The *Suitability for individualization* subscales gained the lowest score between all usability subscales (Table 3) and only 74.4% of users evaluated this criterion as desirable or relatively desirable. It contains a range from changing vocabularies to personalizing user interface and adjusting the system's response time [17]. Although this subscale has gained a score above medium, an important issue is that the sensitive nature of the hospital environment prevents the extensive personalization [24]. 78.1% of users evaluated the *Self-descriptiveness* of HISs as desirable or relatively desirable. Unclear and unintelligible feedbacks do not introduce problem solution and cause user frustration and fatigue. In this study, users were dissatisfied with the complexity of system messages and the difficulty in understanding them. The important items in the self-descriptiveness of a system include displaying general explanations presenting relevant examples and clarifying vocabularies [17, 23]. *Error tolerance* of studied HISs is desirable or relatively desirable according to 78.5% of users' views. Regarding *Error tolerance*, the system must warn the user about problems in both system functions and data entry and prevent minor problems from becoming challenging issues [25]. Requiring confirmation of action before performing is known as the most beneficial item for improving the system's error tolerance [23].

All hospitals received the thereabout the same mean score except hospital A that its' mean score had a remarkable difference with others. Users of this hospital also had more experience in working with the system. Studies have shown that the more experience and better training, the grater user satisfaction and better system objectives achievement will be [8, 21]. Proper training helps users to trust the system and their ability to perform their tasks in the system without discontinuity in daily processes [26]. Experience also stabilizes the user's mental model about the system and motivates them to interact with the system more satisfied [24]. Of course, the internal factors of each hospital are also influential in the perspective of users [27], which needs further investigation.

The first limitation is which this study was performed only in educational hospitals. These hospitals have more resources than non-educational hospitals and provide better training support to their users. It is suggested that another study examines the applicability of these hospitals. The second is the inherent limitation of questionnaire-based surveys that not allow in-depth investigation of users' views and background problems.

This study by identifying system problems, especially in *Suitability for individualization*, *Self-descriptiveness*, and *Error tolerance* fields can help to resolve them and increase the efficiency and effectiveness of the HISs and provide the basis for designing and using other modules and systems, especially clinical cases.

Conclusions

The system's usability of the evaluated systems was above medium, and users appreciate items that were relevant to their business task rather than technical features of the system. Also, the finding indicated that most of the areas, specially *Self-descriptiveness*, *Error tolerance*, and *Suitability for individualization* need further improvement. The current lacks and flaws need to be remedied so that users can benefit from the system more and better. Thus, improving the current system must rely more on facilitating easy navigation, displaying general explanations, and providing more customization options.

List of abbreviations

HIS: Hospital Information System
HIT: Health Information Technology
IT: Information Technology
SUMS: Shiraz University of Medical sciences

Ethical Issues

All procedures performed in studies involving human participants were following the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest

The authors declare that they have no competing interests

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